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THE U.S. CAPITAL STOCK IN THE NINETEENTH CENTURY

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ABSTRACT

This paper -- prepared for and presented at a meeting of the Conference on Research in Income and Wealth -- describes a set of seven capital stock estimates for the U.S., distributed at decennial intervals, 1840 through 1900.

The estimates link with Raymond Goldsmith's work on the twentieth century to form a capital stock series covering well over 100 years of U.S. history. The paper describes the theoretical underpinnings of the new estimates, the sources of the evidence from which they were constructed, the types of estimating procedures followed, and the relationships of the new series to other economic aggregates. A few of the ways in which the series illuminates the nature of the nineteenth century U.S. economy and the course of U.S. economic development are taken up.

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The U.S. Capital Stock in the Nineteenth Century

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1.

This paper describes the results of work begun many years ago by Edward S. Howle and me and carried forward intermittently since then by me. Howle and I estimated the value of the U.S. fixed capital stock (current and 1860 prices) at decade intervals, 1840 to 1900, and circulated in mimeographed form a manuscript describing our estimating procedures (Gallman and Howle, N.D.). This manuscript was never published, although it served as the basis for a number of descriptive and analytical papers by us and by others (Gallman and Howle, 1971; Davis and Gallman, 1973, 1978; Davis et al, 1973, Ch. 2; Gallman, 1965, 1972). While Howle and I thought the estimates were fundamentally sound, we regarded the project as

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incomplete and chose to delay publication until we were more fully satisfied with it. We wanted to run additional tests; in particular, Howle thought that appropriate samples from the manuscript census (Soltow's work (Soltow, 1975) ultimately met our requirements) would give us the means for strong tests of a set of important estimating decisions. A number of minor sectoral estimates had been hastily made, and we believed that they could be improved with more research and a little ingenuity. We also wanted to extend the series to earlier years, add figures for elements of the capital stock ignored in our original manuscript, and work out regional distributions of the totals.

Our decision to delay was a mistake. Both of us were drawn off into other work, I temporarily, Howle permanently. The manuscript entered the underground of research; it was occasionally cited and our data were used, but it was never subjected to the constructive criticism that publication would have brought. We should have remembered that all research is, in a sense, preliminary, and that

to withold work for long serves scholarship badly, however good the motives for withholding may be.

The delay has not been all a waste. In the years since we wrote the original mansucript I have managed to do most of the things we had planned: I have carried out additional tests, thoroughly revised the old estimates (here and there substituting new series), added estimates of important elements of the capital stock that were not treated in the old manuscript, and extended the series to earlier years.[1] This does not mean, of course, that the work is now complete -- sound and durable in every respect. It is certainly not. Gaps remain (for example, there are no figures for the value of roadways), and there are any number of ways in which the existing estimates could be improved. But additions and improvements must be left, for the time being, perhaps to be carried out eventually by other hands. The existing estimates seem to me ready for formal presentation to the scholarly community, at long last.

Part, but not all, of the formal presentation will take place in this paper. There is not space enough here to include estimating details: the notes describing our procedures now run in excess of 200 manuscript pages, more than the Conference would happily publish. In the

present paper I will be able to deal only with the types of estimating procedures and tests adopted and their general results, the identity and character of the principal sources used, and the theoretical concepts that guided the work. These subjects are treated in the next section, Section 2.[2] Section 3 is concerned with the theoretical and quantitative relationships between the new estimates and those already in the field: the Goldsmith and Kuznets series, as well as the original Gallman and Howle figures (Goldsmith, 1952; Kuznets, 1946; Gallman and Howle, n.d.; Gallman, 1965). Section 4 considers the ways in which the new series illuminate the nature of the nineteenth century U.S. economy and the course of U.S. economic development.

The new series contain estimates of the value of land (except agricultural land in 1840). I will use the term "national wealth" to refer to the value of reproducible capital, land, stocks of monetary metals, and net claims on foreigners. "Domestic wealth" will mean the value of reproducible capital and land. Notice that paper claims are excluded from both of these aggregates, as are consumers' durables and human capital. If I have occasion to aggregate across these variables, I will so indicate (e.g. "national wealth,

inclusive of consumers' durables and human capital"). The terms "national capital" and "domestic capital" refer to national wealth and domestic wealth, respectively, minus the value of land. The concepts I refer to as "wealth" and "capital" are sometimes called (by others) "capital" and "reproducible capital," respectively.

2

Uses of Capital Stock Estimates

There are at least four scholarly uses for aggregate capital stock series.

(1) They can be used in place of national product series--or in addition to national product series--to describe the scale, structure, and growth of the economy. There is no reason why, over short, or even intermediate periods, the capital stock should grow at exactly the pace of the national product, but over the long run there should be a considerable degree of similarity. For this reason capital stock series have sometimes been used as proxies for national product series in the measurement of long-term growth (Jones, 1980). But one could easily make a case for the

use of such series as independent indexes of growth, not simply as proxies for national product. Looked at (and measured) in one way, the capital stock of a given year describes the piled-up savings of the past; looked at (and measured) in a different way, it is a vision of future production (see below). Either way, we have a picture of the economy that is different from the one provided by the national product, and one that is analytically useful.

(2) Capital stock series have appeared as arguments in consumption functions and, thereby, in the analysis of the level of economic activity, cyclical variations, and economic growth. Land and consumers' durables are helpful additions to capital in these uses, as are paper claims.

(3) The capital stock is a consequence of savings and investment decisions, with which are tied up choices of technique. The level and structure of the capital stock emerge out of these decisions, and capital stock series figure in the study of them.

(4) Finally, capital stock series are used in the analysis of production relationships and the sources of economic growth, a practice that has been at the heart of one of the major theoretical disputes of the post-war period.

In this paper the capital stock series are put chiefly to the first use and, to a limited extent, to the third and fourth.

2

Methods of Estimating the Capital Stock

Capital stock estimates may be made in two ways: they may be cumulated from annual investment flow data (Raymond Goldsmith's perpetual inventory method--Goldsmith, 1956), or they may be assembled from censuses of the capital stock. If census and annual flow data were perfectly accurate, if the identical concepts were embodied in each, and if appropriate estimating procedures were used, then perpetual inventory and census procedures would yield the same results. In fact, they rarely do, although given the rich opportunities for discrepancies to arise, it is surprising how narrow the margins of difference often are.

The choice between the two techniques turns on the types and quality of data available. From 1850 through 1900 there were six reasonably comprehensive federal censuses of wealth, while for 1805 and 1840 we have census-style estimates constructed by able and informed

contemporaries--Samuel Blodget (1806) and Ezra Seaman (1852)--chiefly from federal data. Investment flow data, from which perpetual inventory estimates might be made, are less generally available. But there are some that offer opportunities for estimates superior to those derivable from nineteenth century census-style data. The best were assembled in the extraordinarily well conceived and careful work of Albert Fishlow (1965, 1966) on the railroads. We used Fishlow's estimates as the bases for our railroad series and similarly exploited the work of Cranmer (1960), Segal (1961), North (1960), Simon (1960), and Ulmer (1960) on canals, the international sector, telephones, and electric light and power. We also built up our own perpetual inventory figures for the telegraph industry and for consumers' durables. No doubt other sectoral estimates could be constructed, with profit, from flow data, although I doubt that the remaining opportunities are quantitatively important. The estimates described in this paper are chiefly (and by necessity) drawn from census-style data (see Table 1).

There are also some aggregate flow data which, while not very helpful in the derivation of sectoral estimates, proved useful in the

construction of aggregate perpetual inventory estimates of manufactured producers' durables and structures -- estimates that we have used for checking the census-style figures and for constructing annual capital stock series. That story is told elsewhere; I will also make brief reference to it subsequently in this paper (see Davis and Gallman, 1973; Gallman, 1983).

Valuation of Capital

In principle, capital stocks might be valued in any number of ways.[3] In practice, there are only three ways of any importance, two of which exist in two variants. (I refer here to current price estimates; constant price estimates are discussed below.) Capital may be valued at acquisition cost (which I will also refer to as book value), at reproduction cost, and at market value.[4]

Acquisition cost corresponds to the notion (expressed above) of the capital stock as piled-up savings. The great difficulty posed by such estimates is that the capital stock of each year is valued in the prices of many years, so that no meaningful comparisons (at least none that comes to my mind) can be made. This difficulty can be

overcome by adjusting the data by means of a general price index--a consumer price index would be best--so that all elements of the capital stock of a given year are expressed in the prices of that year. A capital stock so valued retains the sense of acquisition cost: the valuation expresses the capital stock in terms of foregone consumption. The foregone consumption consists of the consumption goods given up in the year of investment, expressed in the prices of the year to which the capital stock estimate refers. Unambiguous comparisons can thus be drawn -- with the national product of the same year, for example.

The capital stock may also be valued at reproduction cost. Each item is valued at the cost of the resources that would be required to replicate it in the year to which the capital stock estimate refers, given the factor prices and techniques of production of that year. The capital stock thus has the sense of congealed productive resources, valued consistently, so that a summation has a precise meaning. Such estimates are well adapted to the study of production relationships. They avoid, in some measure, the circularity problem implicit in market value estimates. Compared to acquisition cost estimates,

they express the capital stock in terms of current productive resources, rather than historical foregone consumption.[5]

The third system values the capital stock in market prices; that is, each item of capital is appraised at the price it would bring in the current market. The market value of a piece of capital is presumably a function of its productivity, its expected life, and the going rate of interest. The capital stock, so valued, expresses the income that capital is expected to earn, discounted back to the year to which the estimate refers. Such a measure would be useful in consumption function applications, as well as in describing the scale and structure of the economy.

Book and reproduction cost measures differ, theoretically, in that the former measures the capital stock in terms of what was given up to obtain it, while the latter measures the capital stock in terms of what would have to be given up in the current year to reproduce it. In an unchanging economy in equilibrium, these measures would be identical. In an economy in which there were no changes except in the price level, they could be made identical by means of the deflation adjustment described above. In the absence of this adjustment, book value would exceed reproduction

cost whenever the price level was falling, and vice versa. Changes in relative prices could lead to the divergence of the two measures, even after adjustment. Thus if the prices of capital goods fell relative to the prices of consumption goods, adjusted book value measures would exceed reproduction cost, and vice versa. (All of the above analysis rests on the assumption that the market price of new capital goods equals the reproduction cost of these goods. If that is not the case, matters become more complicated, as will appear.) In fact, we know that the price indexes of neither consumption nor capital goods exhibited a very pronounced trend over the last four decades of the ante bellum period, although the latter fell slightly as compared with the former (see Brady, 1964, and Historical Statistics 1960, series E1, 7,8). Between 1859 and 1869-1878, the former rose dramatically, while the latter did not (Gallman, 1966). The two then fell pronouncedly until nearly the end of the century, the latter declining the more markedly. Thus, for the dates of concern to this paper, book value (adjusted and unadjusted) probably exceeded reproduction cost modestly, 1840-1860, and more markedly, 1880-1900; adjusted book value also probably exceeded reproduction cost in 1870.

Book value measures look to the past--what was given up to obtain capital--while market values look to the future--earnings potential. In an unchanging economy in equilibrium, and with perfect knowledge, book value and market value would differ only in that the former treats each piece of capital as though it were new, while the latter does not. Even in an unchanging economy, fixed capital would gradually wear out. Therefore old fixed capital would sell for less than new fixed capital, and a capital stock expressed in market values would be smaller than one expressed in book values. The disparity could easily be removed by deducting capital consumption from the book value measures, producing estimates of net book value.

The effects of changing prices (levels and relative prices) on the relative magnitudes of net book and market values are presumably much the same as the effects of changing prices on the relative magnitudes of book and reproduction cost values (see above). Once we drop the assumption of perfect knowledge, other opportunities for divergences between capital stock estimates based on these two concepts emerge. Specifically, deviations between the expected life of individual pieces of fixed capital (on which capital

consumption allowances rest) and their actual life may arise. These deviations may prove, in practice, not to be serious, in view of the opportunity for errors of opposite direction to offset in the aggregate, although a general change in the rate of innovation could produce an uncompensated deviation.[6] Changes in the interest rate produce systematic shifts in the relative values of assets of differing life expectation, in the market, but do not influence aggregate net book values. Actual changes in the interest rate over the last sixty years of the nineteenth century seem likely to have raised market values above net book values from 1870 onward, but not by much, except perhaps for the year 1900 (Gallman, 1983).

Once allowance is made for capital consumption, reproduction cost (that is, net reproduction cost) ought to be similar to market value. Indeed, if the economy were in equilibirum--such that the market price of new capital equalled its reproduction cost[7]--and if capital consumption allowances followed the pattern implicit in the structure of the sales prices of capital goods of differing vintage, then market value and net reproduction cost would be identical. In fact, however, these conditions are

not met. Market prices deviate from the value of resources used up in production (there are profits or losses) and capital consumption allowances fail to reflect precisely the structure of prices of capital of differing age. Thus divergences arise between market value and net reproduction cost, divergences of a type discussed previously in connection with book and market values.

Finally, it should be said that the deviations among net book value, net reproduction cost, and market value are least marked for items recently produced; in equilibrium, there is no deviation at all for new goods. The faster a capital stock grows, ceteris paribus, the lower the average age of capital and the narrower the differences among book value, reproduction cost, and market value. As will appear, the U.S. capital stock grew at an extraordinarily rapid pace in the nineteenth century. Thus the application of the three concepts might produce net valuations that differed little from one concept to the next. The market value and reproduction cost of inventories also will normally differ little. Thus the more important inventories are in the total capital stock, the smaller the disparity between aggregate reproduction cost and aggregate market value, ceteris paribus. Inventories were, in fact, an

important element of the nineteenth century capital stock, partly because agriculture bulked large in the economy and agriculture held large inventories (e.g., of animals).

If data were readily available and estimates costlessly made, it would be desireable to have sets of capital stock estimates based on acquisition costs, reproduction costs, and market values. Comparisons among the estimates would have interesting analytical uses (e.g., Tobin's "q"). Unfortunately, these conditions do not obtain. Data are less than abundant and less than perfect; the assembly of estimates is not costless.

In recent times the data that have been most abundant have been acquisition cost data, since firms maintain records of sales and purchases and keep books on their capital stock. Given good price data, evidence on purchases and sales can also be converted into perpetual inventory reproduction cost estimates, although the procedure is not problem-free. Market values and census-type figures on reproduction cost are very much harder to obtain. Few elements of the capital stock (apart from goods held in inventory) are sold in any given year. If the capital stock is to be valued at market prices, imputations must be drawn from recorded prices in markets that may be

very thin.[8] Estimating reproduction cost is even more difficult, since it sometimes requires that one work out the cost, in a given year, of producing a good which, in fact, was not produced in that year. These are familiar points. But we should not lose sight of the fact that market and reproduction costs are constantly being estimated, and that there are experts who spend their lives at these tasks -- experts hired by insurance companies, the loan departments of banks, and various tax offices. Indeed, most of us here today who own homes have a fair idea of what they would bring, on the market, or how much it would take to rebuild them, despite the recent gyrations of the real estate market.

In the nineteenth century, book value data were much less common than they are today. Until late in the century, most firms charged off capital purchases on current account. Thus there were few books to refer to when the census taker came around. Perhaps equally important, businessmen did not think in terms of book value. It was much more natural for them to appraise plant and equipment in terms of what it would take to replace it, should it all burn down, or what it might sell for. This was even more clearly the case for farmers and householders viewing their

property. These notions of value seem to have influenced the designers of census questions. While the questions are by no means always crystal clear, they seem to refer most often to market value or net reproduction cost. (The two concepts are not always clearly distinguished.) There is little doubt--especially for the first three or four census dates--that book value was only rarely sought by census takers. How rarely is a matter on which there is not full agreement. Howle and I decided that most of the census returns we used were expressed in market values or net reproduction costs (see Table 1). But I grant that we sometimes stand in opposition to very good authority. For example, Kuznets (1946) and Creamer, Borenstein, and Dobrovolsky (1960) believe that the manufacturing censuses, 1880-1900, returned book value. Howle and I disagree.

I do not have the space in this paper to argue Howle's and my case with respect to this matter, although I will do so on another occasion. As my previous remarks have suggested, the distinctions among book value, market value, and reproduction cost may not have great practical significance, in any case, so far as the nineteenth century capital stock is concerned,[9]

especially in view of the wide margins for error that must be assigned to the estimates. What is more important is the question of whether the census measurements of fixed capital are net or gross. Here we have access to a test that does not rely on the interpretation of nineteenth century language. We can check the census data (land improvements and manufactured producers' durables, separately) against perpetual inventory estimates based on reproduction cost. The story of these tests has been told elsewhere (Davis and Gallman, 1973; Gallman, 1983) and will be told again in more detail in still another place, so I offer only a brief summary here: The net reproduction cost estimates check quite closely with the census aggregates before the Civil War, suggesting that the latter are, indeed, net valuations. There is also some support for the notion that the census valuations refer to reproduction cost and that they are accurate. The post-war fit is poorer, but the evidence for the belief that the census figures are net is strong: the perpetual inventory figures typically exceed the census figures.

Our estimates of agricultural land improvements (clearing, breaking, fencing, draining, irrigating) depend chiefly on census physical stock data (e.g., acres of improved land)

Table 1: Estimation Methods, Valuation Bases, and Principal Sources, National Capital Stock Estimates, Current Prices, 1840-1900

	Estimation Methods[a]		Valuation Bases[b]			Principal Sources[c][d]	
	Perpetual Inventory	Census	Book Value	Reproduction Cost	Market Price	U.S. Census	Other
Panel A: By Sectors							
Agriculture		X		X	X	X	X
Mining		X			X	X	
Manufacturing		X			X	X	
Non-Farm Residences		X			X	X	X
Trade		X			X	X	X
Shipping		X			X	X	X
Canals and River Improvements	X		X			X	X
Railroads	X			X			X
Street Railroads		X	X			X	
Pullman and Express Cars		X		X		X	
Telephone	X			X			X
Telegraph	X			X			X
Electric Light and Power	X			X			X
Pipelines		X	X				X
Churches		X			X	X	X
Government Buildings	X	X	X				X
Schools		X			X		X
Inventories (Excl. animals)	X				X	X	X
International Sector	X	X	X[e]				x

Table 1--Continued

Panel B: Fraction (%) of the Total Value of the National Capital Stock (Current Dollars) Corresponding to Each Description, by Years

1840	19	81	3	38	59	20	80
1850	23	77	2	34	64	50	50
1860	23	77	2	33	65	50	50
1870	27	73	1	27	72	50	50
1880	29	71	1	30	69	55	45
1890	26	74	1	26	73	60	40
1900	27	73	3	25	72	60	40

(a) "Perpetual inventory" is used here to refer to any and all cases in which estimates were derived from flow data; "census," to any and all cases in which estimates were derived from stock data.

(b) There remain some doubts concerning valuation bases (see text). In particular, a number of the estimates identified as expressed in market prices may, in fact, refer to net reproduction cost.

(c) Both columns are checked (Panel A) in cases in which the census was the principal source in certain years, but not in others, and in those cases in which the census and some other source were about equally important in all years.

(d) The percentages in Panel B are rough estimates of the relative importance of census and non-census sources.

(e) Less bad debts.

and various coefficients developed from the work of Martin Primack (1962). Given the form of the data, we were restricted to the construction of reproduction cost figures. Fishlow's (1965, 1966) estimates of railroad investment also rest on physical data, as do our estimates for the telegraph industry. In these cases, however, the form of the data left open the possibility of constructing book value series. In order to maintain consistency with most of the rest of the work--and because we believed they would prove more useful--we chose to produce reproduction cost estimates instead.

The capital stock figures, thus, consist chiefly of net reproduction cost or market value estimates, as Table 1 indicates. The assignment of items to the reproduction cost category in that table is sure, but the same cannot be said of the estimates referred to as "market value." For a number of these, the valuation may, in fact, refer to net reproduction cost. The practical distinctions between these two types of measures on the dates to which the capital stock estimates refer, however, are unlikely to be very important, for reasons previously given.

All of the data--including the federal census data--underwent considerable processing and

testing during the construction of the estimates. The estimating and testing notes are much too extensive to be included here. Some general statements of appraisal can be ventured, however.

The evidence is considerably weaker for 1840 and 1870 than for the other census dates. The 1840 census provided much less comprehensive wealth data than did the censuses in subsequent years (although with respect to the trade sector it was unusually helpful). Also, prices fell dramatically across that census year, which means that it is very important to date the available evidence correctly. We cannot be absolutely sure that we have done so. The census dragged on for an inordinate length of time, so that the dating of census magnitudes is problematical. We also were obliged to depend heavily on the work of Ezra Seaman (1852), who was not always entirely clear as to his valuation base. The 1870 census came at a difficult time, and it is widely believed that Southern wealth was badly returned (Ransom and Sutch, 1975). Nonetheless, it must be said that the results of the perpetual inventory tests for these two dates do not impugn the stock estimates. Of course the test is particularly difficult to run for 1840 and 1870, and the results must be regarded as particularly chancy. Still, it is

moderately reassuring that the stock and flow estimates are at least as consistent at these dates as at any others in our series.[10]

The test for 1880 is less successful. It suggests that our stock estimates at that date--for both equipment and improvements--may be too low. These are matters to which I will return, below. It is perhaps sufficient to say here that the capital stock figures are much more likely to tell an accurate story of the long-term rate of growth and structural changes of the capital stock than of the decade-to-decade changes, and this is particularly true after 1860.

Constant Price Series

The best capital stock deflators available are to be found among the price index numbers assembled by Dorothy Brady (1966) to deflate components of the GNP. The Brady indexes are the best for several reasons: they are true price index numbers of capital goods (including structures); they are available in considerable detail; they were constructed with careful regard to their theoretical meaning; and their theoretical meaning makes them reasonably apt deflators for capital stock series valued in terms

of reproduction cost or market value (see also Brady, 1964). They are not perfect, but, in the absence of price data for old capital, they are as close to perfection as can be had. They are linked price indexes describing, in principle, the movement of the prices of capital goods of unchanging quality. If the economy were in equilibrium in all the relevant years, such that market prices and reproduction costs of new goods were identical, and if the prices of new and old goods moved closely together over time (i.e. the interest rate was the same at each relevant date and the rate of obsolescence was unchanging), then deflation of capital stock estimates valued in market prices or net reproduction costs would yield a constant price series expressed in net reproduction costs. That is, it would produce a series in which each element measured the net reproduction cost of the capital stock, given the factor prices and techniques of producing capital goods of the base year. Of course these conditions were surely not met: I have already pointed out that the interest rate changed, affecting the relative magnitudes of market value and reproduction cost. Nonetheless, the constant price capital stock series approximates more nearly to a reproduction cost series than it does to any other

coherent concept. I will treat it as such, therefore, throughout the rest of this paper.

While the Brady indexes were the chief deflators we used, other price data figure in important ways in the construction of the constant price capital stock series. Some important components of the capital stock were built up by placing values on counts of capital goods, described in physical terms. In these cases--improvements to agricultural land (structures apart), railroads, the telegraph, farm animal inventories, crop inventories--constant price estimates could be made directly from the evidence on physical counts and base year prices, and we could be sure that the series so constructed were true reproduction cost series, or very close thereto. Inventories of manufactured goods and imports were deflated with price indexes germane to the types of products incorporated in these inventories, drawn from sources other than the Brady papers (Gallman, 1960; Historical Statistics, 1960, series U-34, E-1, E-70).

The Brady indexes refer to the census years (beginning on June 1 of the years ending in 9 and ending on May 31 of the years ending in zero) before the Civil War, and to calendar years ending in 9 after the Civil War. The current year capital

stock valuations to which the Brady indexes apply refer to June 1 of the years ending in zero. I was therefore obliged to adjust the Brady indexes, on the basis of other available price data, to make them conform to the appropriate dates. Gaps in the coverage of the Brady indexes were filled similarly.

3

There are both conceptual and substantive differences between the old Gallman-Howle capital stock estimates and the new ones reported on in this paper. The conceptual differences are the more important.

When Howle and I estimated the value of property employed in agriculture we decided to extract from the value of agricultural land (and to list separately) the value of agricultural structures, but to treat all other agricultural improvements as part of the value of land. We wanted to be able to link our series with series extending into the twentieth century, and we believed that this treatment of agricultural land and improvements would bring our work into conceptual alignment with the twentieth century estimates.[11] When I came back to this work I decided that a second set of estimates should be made, in which all land improvements are treated as capital, as of course they are. These estimates would go to make up a capital stock series roughly corresponding, conceptually, with the GNPII series

of my paper in Volume 30 of Studies in Income and Wealth (Gallman, 1966). For purposes of analyzing nineteenth century developments, the GNPII series is certainly more appropriate than the GNPI series; similarly, the broader capital stock series would be superior for these purposes to the narrower one.

I made estimates of the reproduction cost of clearing and breaking farm land, fencing it, and draining and irrigating it, all of these estimates based on the work of Martin Primack (1962), as I have previously indicated. The value of fences was taken net of capital consumption. Retirements were deducted from the other items, but no allowance was made for capital consumption, on the ground that normal maintenance would prevent physical deterioration of these improvements. Clearly some deduction in value should have been made to account for the deterioration of improvements on land withdrawn from production but not yet returned, for census purposes, as unimproved (i.e., retired), but I could devise no system for making this type of adjustment. The improvements estimates are therefore almost certainly overstated, as compared with the values recorded

for other elements of the capital stock. How important this matter may be, I do not know, although I doubt that it is of great importance.

Farm improvements (exclusive of structures) constituted a very large part of the capital stock, but a part that declined in relative importance as time passed. Thus roughly six-tenths of the agricultural capital stock consisted of these improvements in the years 1840 and 1850, a fraction that fell to less than half, in current prices, in 1900, and something over one half, in constant prices. The fraction of total domestic capital accounted for by these improvements fell from between three and a half and four-tenths in 1840, to just over one-tenth in 1900 (see Table 2). It should be clear, then, that the new Gallman-Howle capital stock series, inclusive of improvements, is substantially larger than the old one, and exhibits a substantially lower rate of growth. These are matters to which I will return below.

As I have already indicated, I also made a number of substantive changes to the old Gallman and Howle series. So far as the current price series are concerned, the chief changes are as follows: I substituted Weiss's estimates of government buildings for the very preliminary

Table 2: Ratios of the Value of Farm Improvements (Exclusive of Structures) to the Value of U.S. Farm Capital and the Value of U.S. Domestic Capital, Current and Constant Prices, 1840-1900[a]

	Ratio of Value of Improvements to Value of:			
	Farm Capital (Current Prices)	Domestic Capital (Current Prices)	Farm Capital (1860 Prices)	Domestic Capital (1860 Prices)
1840	.58	.34	.61	.38
1850	.59	.30	.61	.34
1860	.56	.27	.56	.27
1870	.51	.22	.55	.24
1880	.51	.18	.58	.22
1890	.48	.14	.55	.14
1900	.49	.13	.54	.12

[a] The denominators include farm improvements.

Sources: see text.

estimates Howle and I originally used (Weiss, 1967); I changed the original animal inventory estimates, making them more comprehensive (Howle and I had originally included only mature animals); I altered the estimates of non-agricultural residences and trade capital for 1870, the adjustments resting on evidence unavailable to Howle and me when we built up our original series; I improved the price indexes for shipping and railroad capital, which affected only the current price series, since the constant price series were estimated directly from data on physical capital. On balance, these changes are small so far as the years 1840, 1850, 1860, and 1880 are concerned: in these years the new and old[12] national wealth series are within one and a half percent of each other, once allowances are made for differences in coverage between the two series.[13] In the remaining three years, the margins are much wider: about 8 1/2 percent in 1870, and about 4 percent in 1890 and 1900, the new estimates being below the old in each year. For 1890 and 1900, the principal explanation lies in the changes I have made in the price indexes used to convert the constant price railroad improvments series into current prices. Originally, Howle and I had used Ulmer's (1960)

index, despite Fishlow's (1965, 1966) warning that the price series incorporated therein and the weights attached to them made the index inadequate for our purposes. I have now replaced this index by a new one, in which I have considerably greater confidence.[14]

The new railroad improvements price index and the new price index for vessels in the merchant marine and fishing fleets also affected the 1870 estimates, making the new ones lower than the old ones. Much more important, however, is the fact that I have now re-worked the 1870 estimates of non-farm residences and of the capital of the "trade" sector (the "other industrial" sector, in Kuznets's (1946) terminology). The new estimates were adopted as the result of tests based on evidence supplied by Lee Soltow (1975), evidence that was not available to Howle and me when we constructed our original series. The new estimating procedures are very much stronger than the old ones were, and a test for internal consistency provides strong support for the results. Nonetheless one cannot be sure that the new estimates are actually closer to the truth than were the old ones. Both sets depend upon data from a census that under-enumerated the population, and probably undercounted property as

well (Ransom and Sutch, 1975). Since the new estimates are lower than the old ones, it may very well be that they reflect the true value of the relevant property less accurately than do the old estimates, despite the fact that they rest on technically superior procedures.

Some, but not all, of the changes in the current price series, described above, affect the constant price series as well. I also made a few small alterations in those constant price series that were built up from counts of physical capital (e.g. the railroads). More important is the fact that I made some adjustments to the price index numbers. Howle and I received many of the price indexes we used in correspondence with Dorothy Brady. In a few cases, Dr. Brady subsequently revised her figures. Howle and I also used the Brady indexes without adjustment, although, in fact, they did not refer to precisely the dates we required (see the discussion of this point above). When I returned to the estimates, I corrected the price indexes, so that they reflected Dr. Brady's last word on the subject and so that the indexes were more nearly relevant to the dates to which the censuses refer. The principal changes, substantively, were to raise the 1840 estimates of agricultural buildings and non-farm residences,

and to lower the estimates of machinery and equipment in manufacturing, 1890 and 1900, and the "trade" sector, 1870-1900. Of these alterations, the ones referring to 1840 are most doubtful. In these cases I was obliged to build up new price indexes for structures to replace an index number abandoned by Dr. Brady. It may very well be that my new indexes--based, as they are, on materials prices and wage rates--actually understate the price levels of structures in 1840.[15] If that is the case, using these indexes to deflate the 1840 values may have produced an over-statement of constant price values in that year. However, all the tests I have run so far suggest that this has not happened. On balance, the changes I have made in the constant price series have not been of overwhelming quantitative significance (in no year do they amount to more than 10 percent of the value of the domestic capital stock), but they are far from negligible, and since the adjustment for 1840 is in an upward direction, and the ones for 1870-1900 in a downward direction, the rates of long-term growth are lower when computed with the new series than when computed with the old one, even when the two series are put on the same conceptual basis.

The old series, expressed in constant prices, was never published, but a set of index numbers based on it appeared in American Economic Growth: An Economist's History of the United States (Davis, Easterlin, Parker et al., 1972). These index numbers provide the best bases for comparing the old with the new series.

The comparisons can be made with data in Table 3, which show that the new series describe lower long-term rates of growth than do the old (Panels A and C). The disparities are the wider when the new series, inclusive of all farm land improvements (Variant A in the table), is compared with the old series. That is reasonable enough, in view of the conceptual difference between the two series and the well known fact that the agricultural sector grew at a slower pace, over the last six decades of the century, than did the rest of the economy. But even when the conceptual difference is removed--the Variant B series is substituted for the Variant A series--the new estimates exhibit somewhat lower long-term rates of growth than do the old. The margins are not great, however--less than half a percentage point in every case, an adjustment of less than one-tenth in each of the long-term rates of growth. The data on the decadal rates of growth

Table 3: Comparisons of the New and Old Gallman and Howle National Capital Stock Series, 1860 Prices, 1840-1900

Panel A: Index Numbers on the Base 1860=100

	1840	1850	1860	1870	1880	1890	1900
(1) New Series, Variant A[a]	38	57	100	117	179	328	476
(2) New Series, Variant B[b]	31	52	100	121	190	385	571
(3) Old Series	28	51	100	143	220	437	656

Panel B: Annual Rates of Growth, Short Intervals

	1840-1850	1850-1860	1860-1870	1870-1880	1880-1890	1890-1900
(1) New Series, Variant A[a]	4.2%	5.8	1.6	4.3	6.3	3.7
(2) New Series, Variant B[b]	4.8	6.9	1.9	4.6	7.3	4.0
(3) Old Series	6.1	7.0	3.7	4.4	7.1	4.2

Panel C: Annual Rates of Growth, Long Intervals

	1840-1900	1850-1900	1860-1900	1870-1900	1880-1900
(1) New Series, Variant A[a]	4.3%	4.3%	4.0%	4.8%	5.0%
(2) New Series, Variant B[b]	5.0	4.9	4.5	5.3	5.5
(3) Old Series	5.4	5.3	4.8	5.2	5.6

[a] Includes all improvements to farm lands.

[b] Excludes all improvements to farm land except structures.

Sources: New Series: Derived from data in or underlying Table A

Old Series: Derived from data in Davis et al, 1972.

show, moreover, that in only two decades--1840-1850 and 1860-1870--are the disparities in growth rates at all wide (Panel B). These are the decadal growth rates that are affected by the major estimating changes described above, of course. It should also be pointed out that the new and old series exhibit the same patterns of change over time, the rate of growth rising from 1840-1850 to 1850-1860, falling to 1860-1870, rising again to 1870-1880 and 1880-1890, and finally falling to 1890-1900.

On the whole, then, the new series differ from the old in important respects, but once allowance is made for differences in concept and coverage, they appear to tell roughly the same story with respect to the rate of growth of the capital stock. (The subject is treated further, below.)

When Howle and I first came to this topic there were in the field two sets of comprehensive capital stock estimates covering a substantial part of the nineteenth century, Simon Kuznets's series, reported in National Product since 1869 (1946), which cover the years 1880, 1890, and 1900, and Raymond Goldsmith's revisions to the Kuznets figures and extension of them to 1850, reported in Income and Wealth, Series II (1952).

Table 4: Ratios of the Goldsmith (1850, and elsewhere where indicated) and Kuznets (1880-1900) Capital Stock Estimates (Current Prices), to the New Gallman-Howle Estimates

	1850	1880	1890	1900
A. Fixed Reproducible Capital				
(1) Agriculture (Variant B)[a]	1.00	.97	.97	1.00
(2) Mining		1.21	1.15	1.32
(3) Manufacturing		.72	.80	.85
(4) Other Industrial (Trade)		1.56	1.27	1.28
(5) Non-farm Residences-				
Goldsmith	1.14	1.20	1.15	1.28
-Kuznets		.83	.72	.81
(6) Steam Railroads		1.54	1.56	1.71
(7) Street Railroads		1.00	1.00	1.00
(8) Pullman Cars		1.32	1.37	1.57
(9) Telephones		6.36	4.08	3.25
(10) Shipping, Canals, and River Improvements		.85	.92	.95
(11) Electric Light and Power			1.63	1.42
(12) Waterworks	(not estimated by Gallman and Howle)			
(13) Irrigation		1.33	1.31	1.02
(14) Pipelines		1.00	1.00	1.00
(15) Tax-Exempt Property	.71	1.00	1.33	1.47
B. Inventories (Goldsmith)				
(1) Farm Livestock	.92	1.05	.96	1.06
(2) Monetary Metals	1.00	1.20	1.00	1.00
(3) Net International Debits	1.50	.69	.97	.92
(4) Other Inventories	.50	.94	1.06	.93
C. Totals				
(1) Fixed Reproducible Capital-Kuznets		1.08	1.01	1.09
(2) National Capital-Goldsmith	.89	1.17	1.16	1.19

[a] Excluding land improvements, other than structures.

Sources: Goldsmith (1952)

Kuznets (1946)

Data underlying Table A

There were also a good many sectoral estimates for the late nineteenth century, deriving from a major program at the N.B.E.R. in which Creamer, Dobrovolsky, and Borenstein (1960), Ulmer (1960), Grebler, Blank, and Winnick (1956), and Tostlebe (1957) participated. (See, also, Kuznets, 1961, and Kendrick, 1961.) Finally, there were a number of helpful independent pieces of work, some of them developed in connection with the Volume 24 and 30 meetings of this Conference: work by Fishlow (1965, 1966), Cranmer (1960), Segal (1961), Primack (1962), Lebergott (1964), North (1960), and Simon (1960) (see also Gallman, 1960). Since then the research of Soltow (1975) and Weiss (1967) has provided additional materials that I have found helpful.

Howle and I began with Kuznets's National Product since 1869 (1946), which provided us with the framework within which we have subsequently worked. The volume contains very detailed estimates, together with full descriptions of estimating procedures. Our idea was to modify Kuznets's estimates in light of the work that had come forward since National Product since 1869 was published, and to extend the estimates to the years 1840, 1850, 1860, and 1870. The Goldsmith

(1952) estimates for 1850, while available in less detail, were to serve as an ante-bellum benchmark.

The extent to which the new Gallman-Howle series now deviate from the Kuznets and Goldsmith estimates is exhibited in Table 4. It will be seen that in the cases of fixed reproducible capital in farming, street railroads, shipping, canals, river improvements, and pipelines and in the cases of inventories of farm livestock and monetary metals, the differences are slight (in the cases of street railroads and pipelines there are none at all). For the rest, there are substantial differences. As they relate to the Kuznets and Gallman-Howle estimates, they tend to cancel out, so that the values of aggregate fixed reproducible capital fall within ten percent of each other in each year, the Kuznets figures being the higher. The net gaps between the Goldsmith and the new Gallman-Howle estimates are wider and they also run in opposite directions in 1850 and the later years. Thus the Goldsmith series describes a substantially higher rate of growth across the nineteenth century than does the Gallman-Howle series, even when differences of concept and coverage are eliminated.[16]

The differences between our work and that of Goldsmith and Kuznets have emerged in part because

we had available evidence unavailable to them, in part because we have interpreted some of the evidence available to all of us in a new way, and in part because we have adopted, here and there, different concepts. In the cases of the estimates relating to agriculture, the "other industrial" (or "trade") sector, non-farm residences, steam railroads, telephones, canals and river improvements, electric power and light, irrigation, tax-exempt property, and international claims, we were the beneficiaries of substantial amounts of research that came forward only after Goldsmith and Kuznets had published. We did a certain amount of new research particularly with respect to inventories and the telegraph, and we worked out new interpretations of existing evidence in a number of places, notably in the cases of mining and manufacturing (we believe that rented real estate was inadvertently left out of Kuznets's manufacturing estimates). Finally, in a number of cases (e.g., steam railroads, the telegraph) we chose to substitute estimates of net reproduction cost for book value.

In summary, then, the new Gallman-Howle capital stock estimates are net of retirements and net of capital consumption. While a few of the components (current prices) are expressed in book

values, most are in market prices or in net reproduction costs. Conceptually, the new series differ importantly from the old; substantively, somewhat less. The substantive differences between the new series and the Goldsmith and Kuznets nineteenth century series are wide enough that one might anticipate that accounts of economic structure and change based on the new series would offer an element of novelty. It is to this matter that I now turn.

4

Rates of Growth

To say that the nineteenth century U.S. capital stock increased rapidly or slowly is to make a comparative statement. It is to say that the stock increased rapidly or slowly compared to other times--earlier or later--or to other places. So far as earlier times are concerned, Alice Jones's (1980) wealth data for 1774 and my own figures for the early part of the nineteenth century would provide bases for a relevant comparison. But my own estimates for the early part of the century are not quite ready to be put to this use and I am therefore obliged to defer this matter.

There is no reason to defer consideration of subsequent ~~items~~ times, however. Raymond Goldsmith's recent extension of his estimates to 1980 provides us with data covering virtually the entire twentieth century (Goldsmith, 1982). These data

differ from the Goldsmith series discussed in the previous section. The latter consisted chiefly of census-style estimates, whereas the twentieth century series were built up by perpetual inventory procedures. In concept, the new Gallman-Howle Variant B estimates are virtually identical to Goldsmith's twentieth century series.[17] Where the two overlap--at 1900--they are also substantively quite similar. Where differences of detail appear, aggregating up to the next relevant level virtually removes them. For example, the estimates of agricultural structures and equipment differ, in the two series, in 1900, but the sums of the two--agricultural fixed capital--are virtually identical. The same is true with respect to non-farm rsidential land and non-farm residential structures.[18] Thus the two series link together reasonably well, providing coverage for a period of 140 years, the link being particularly good at the level of what I have called domestic wealth (see Section 1, above). Here, however, I will be comparing Goldsmith's domestic capital series with the Gallman-Howle national capital series. For present purposes, the consequences of the conceptual and substantive differences between the series are trivial.

According to Goldsmith, domestic capital (reproducible tangible assets, narrow definition), in current prices, increased at an average annual rate of 5.79 percent between 1901 and 1929, 5.00 percent between 1930 and 1953, and 8.20 percent between 1954 and 1980. These are, on the whole, higher rates of change than are exhibited by the Gallman-Howle series over similarly extended periods (see Table 5), and this is true whether one looks at the Variant A or the Variant B series. The explanation lies in the price history of the two centuries. While prices rose and fell dramatically in both the nineteenth and twentieth centuries, the long-term drift in the former period was neither powerfully upward nor powerfully downward. That is not true of the twentieth century, however. Prices moved strongly upward, on average, between 1901 and 1929, 1930-1953, and 1953-1980. Thus, deflating on the base 1929, one finds that the real capital stock increased at rates of only 3.60 percent, 1.68 percent, and 3.60 percent, in the three periods, lower than most of the rates exhibited in Table 5.[19] Over the full sweep of the years 1900 through 1980, the current price series rose 6.36 percent per year, on average, while the constant price series increased only 2.80 percent, the former

Table 5: Rates of Growth of the National Capital Stock and the National Product, 1840-1900

Panel A: Current Price Data

	Variant A[a]		Variant B[a]	
	Capital Stock	GNP[b]	Capital Stock	GNP
Long-Term				
1840-1900	4.5%	3.9%	5.0%	4.0%
Intermediate				
1840-1860	5.9	4.9	6.5	5.1
1860-1900	3.7	3.4	4.2	3.4
1870-1900	3.7	(2.9)[c]	4.1	(2.9)[c]
1860-1880	3.4	4.1	3.9	4.2
1880-1900	4.1	2.6	4.5	2.7
Short-Term				
1840-1850	4.9	3.8	5.6	4.2
1850-1860	6.9	6.1	7.5	6.0
1860-1870	3.8	(4.3)[d]	4.4	(4.3)[d]
1870-1880	2.9	(3.8)[e]	3.4	(3.9)[e]
1880-1890	5.1	2.5	5.7	2.6
1890-1900	3.1	2.8	3.3	2.8

Panel B: Constant Price Data

Long-Term				
1840-1900	4.3%	4.0%	5.0%	4.1%
Intermediate				
1840-1860	5.0	4.7	6.0	5.0
1860-1900	4.0	3.6	4.5	3.7
1870-1900	4.8	(4.0)[c]	5.3	(4.1)[c]
1860-1880	3.0	3.6	3.3	3.6
1880-1900	5.0	3.6	5.5	3.7
Short-Term				
1840-1850	4.2	4.4	4.8	5.0
1850-1860	5.8	4.9	6.9	4.9
1860-1870	1.6	(3.0)[d]	1.9	(3.0)[d]
1870-1880	4.3	(5.4)[e]	4.6	(5.6)[e]
1880-1890	6.3	4.1	7.3	4.2
1890-1900	3.8	3.1	4.0	3.1

Table 5 (continued)

Panel C: Implicit Price Index Numbers

	Variant A Capital Stock	GNP[b,d]	Variant B Capital Stock	GNP[b,d]
1840	84	97(94)[g]	90	99(94)[g]
1850	89	91(95)[g]	94	91(96)[g]
1860	100	100	100	100
1870	123	(123)[h]	126	(123)[h]
1880	108	113	112	115
1890	96	97	97	97
1900	91	94	90	94

[a] The Variant A measures include improvements to agricultural land; the Variant B measures exclude all such improvements, other than structures.

[b] The dates to which the GNP estimates refer differ slightly from the dates in the stub:

Stub	GNP estimates
1840	1839
1850	1849
1860	1859
1870	mean of 1869-1878
1880	mean of 1874-1883
1890	mean of 1884-1893
1900	mean of 1894-1903

[c] These rates of growth were computed from data for 1869-1878 and 1894-1903 (means of annual data) and thus refer to the period 1873.5 to 1898.5.

[d] These rates of growth were computed from data for 1859 and 1869-1879 (mean of annual data) and thus refer to the period 1859 to 1873.5.

[e] These rates of growth were computed from data for 1869-1878 and 1874-1883 (means of annual data) and thus refer to the period 1873.5 to 1878.5.

(f) The dates to which the GNP estimates refer differ slightly from the dates in the stub:

Stub	GNP Estimates
1840	mean of 1834-1843
1850	mean of 1844-1853
1860	1859

For the rest, see note (b) above.

(g) The implicit price indexes were computed from annual current price data (1839, 1849) and decade average constant price data (1834-1843, 1844-1853)--see notes (b) and (f), above. The index numbers in parentheses were computed from annual data, above (1839, 1849).

(h) Refers to the period 1869-1878.

Sources: (1) Data underlying Table A.

(2) GNP estimates: Variant B--Gallman (1966), p. 26, Table A-1. (See note (b), above.) Variant A--Computed from Gallman (1966), pp. 26 and 35, Tables A-1 and A-4, Variant I, and the implicit price index of improvements to farm land (exclusive of structures) computed from data underlying Table A below. GNP A is defined as conventional GNP plus the value of improvements to farm land (Table A-4 in Gallman (1966)). I assume that average annual improvements, 1849-1858, were equal to improvements in 1859. Constant price improvements (Table A-4 in Gallman (1966)) were converted to current prices by means of the price index of agricultural land improvements (exclusive of structures) implicit in the data underlying Table A, below. I assumed that the value of improvements (current and constant prices) in 1839 and 1849 were equal to the mean value, 1934-1843 and 1844-1854, respectively.

substantially higher and the latter substantially lower than the long-term nineteenth century rates (see Table 5). Comparing the experiences of the two centuries, then, we find marked retardation of the rate of growth of the real magnitudes, just as had been previously discovered with respect to the real national product (Gallman, 1966).

By the standard of twentieth century experience, the capital stock grew rapidly between 1840 and 1900. My guess is that further work will show that it also grew rapidly by the standard of what had gone before. But what of the third standard mentioned above that of experience in other places? I am not yet in a position to make meaningful direct comparisons of this type, but a fairly obvious indirect one can be made. We know that the U.S. real national product increased between the 1830's and 1900 at an exceptionally high rate, the judgment resting on observations for many countries (Gallman, 1966; Davis, Easterlin, Parker et al., 1972, Ch. 2). Unless the rates of change of capital stocks and national products diverged widely--which is highly improbable--the U.S. capital stock must also have grown rapidly, compared with experience elsewhere. That means that the U.S. capital stock was probably a relatively young one, with a high

proportion of the stock embodying best-practice techniques (Gallman (1978)).

In fact, the data of Table 5 show that the capital stock actually grew faster than the national product, in both current and constant prices, in both variants, over long periods and over most of the short periods identified in the table. That fact has a rather important set of implications. But before considering them, it will pay us to look at other aspects of the evidence in the table.

Rates of change of both Variants A and B of the capital stock are contained in Table 5. It will be observed that the rates of change of the Variant B series are always at least as large as the rates of change of the Variant A series, and usually larger. One should recall that the Variant A series includes investment in agricultural land clearing, fencing, and the construction of drainage and irrigation ditches, while the Variant B series does not. The Variant A series grew the more slowly because this component of the capital stock increased at a below-average pace. This, in turn, was a consequence both of the fact that the value of improvements of this type (measured in reproduction costs) constituted a declining fraction of the value of the agricultural capital

stock (in both current and constant prices), and of the fact that the agricultural sector--including the capital stock thereof--grew more slowly than the rest of the economy. The former development reflected both a slowing in the rate (percentage) at which agricultural land was being added to the stock and the continued high rates of increase of the stocks of agricultural structures and equipment, particularly the latter. Agriculture was becoming more highly mechanized.

A second feature of the table worth remarking is that the rates of growth recorded therein exhibit, on the whole, a downward long-term movement. This is true of both of the GNP series, in current and constant prices, both of the capital series, in current prices, and the Variant B series, in constant prices. The Variant A series, in constant prices, is only a moderate exception. It exhibits lower rates of growth for the periods 1860-1900 and 1870-1900 than for 1840-1860, which makes it consistent with the Variant B and GNP series, but if the peribd is broken into three equal lengths, the Variant A series shows equal rates of growth for 1840-1860 and 1880-1900, the rate for the period 1860-1880 being considerably lower. This is the one bit of evidence running against a conclusion of general

retardation in rates of growth across the latter part of the nineteenth century. The exception is not a very important one, however, in view of the reservations expressed above concerning the 1880 capital stock figure. If the estimate for that date is, indeed, biased downward, then an appropriate adjustment would remove this one exception to the general finding of retardation in the rates of growth of the GNP and the capital stock, a development begun in the nineteenth century and continued in the twentieth.

A third piece of information emerging from the table is that the decade-to-decade variations in the rates of growth of the GNP and the capital stock are reasonably consistent. Thus the long-swing boom of the 1850's clearly emerges from the record provided by Table 5, rates of growth rising above the levels attained in the 1840's (exception: the current price GNP Variant B series), while the rates of change of all series drop sharply in the Civil War decade, 1860-1870.[20] Between 1870 and 1880 the rates of change of the current price series continue to fall, reflecting the price deflation of the period, while the rates of change of the real series all rise. All of these variations are reassuring. They correspond to what one might have expected, from a

knowledge of the qualitative history of the period and of quantitative studies of a micro variety. It is also reasonable to expect the rates of change of the GNP and capital stock series to move together as they do. These features of the table thus enhance one's confidence in the capital stock series, but (necessarily) offer no new insights into the period.

The consistency in the movements of the rates of change of the two sets of series ends with 1880. Thereafter, the rate of growth of the GNP series, expressed in constant prices, falls persistently, while the rate of growth of the current price series falls and then rises. The rates of change of the current and constant price stock series follow neither of these patterns, rising betwen 1880 and 1890, and falling between 1890 and 1900. Thus the variations in the rates of growth of the GNP and capital stock series diverge across the last two decades of the century. Once again, if the capital stock estimate for 1880 is, indeed, too low, adjusting it might bring the patterns of change of the two series more nearly into line.

Sources of Growth

Finally, the data in Table 5 offer the opportunity to re-work the "sources of growth" calculations that I derived on the basis of the old Gallman and Howle series and presented on two earlier occasions (Davis, Parker, Easterlin et al., (1982); Gallman (1980)). The results of this reworking, together with the old figures, appear in Table 6. In making my revisions I have left everything unchanged from the earlier set of calculations, with the following exceptions: in the case of the new calculations based on the Variant B series, I re-computed the contributions of the capital stock and productivity; in the case of the new calculations based on the Variant A series, I re-computed the contributions of capital, productivity, and land. The Variant B series is conceptually identical to the old Gallman-Howle series, it will be recalled. It was therefore possible to substitute it into the calculations without changing anything else, except, of course, for the contribution of productivity change to economic growth. Since productivity change is taken as a residual, the introduction of a new capital stock series necessarily produced changes in the productivity figures. The Variant A series differs conceptually from the old Gallman and Howle series,

Table 6 Contributions of Factor Inputs and Productivity to the Growth of Net National Product and Net National Product per Capita, 1840-1960

Panel A: Average Annual Rates of Growth

I- Net National Product

	1840-1900			1900-1960
	Old Est.	New Est. Var A	New Est. Var B	Old Est.
(1) Labor Force	1.88%	1.88%	1.88%	1.09
(2) Land Supply	.38	.13	.38	.08
(3) Capital Stock	1.03	1.12	.94	.58
(4) Productivity	.69	.85	.78	1.38
(5) Totals	3.98	3.98	3.98	3.12

II- Net National Product per Capita

(1) Labor Force	.17%	.17%	.17%	.11
(2) Land Supply	.05	.02	.05	-.01
(3) Capital Stock	.55	.42	.46	.28
(4) Productivity	.69	.85	.78	1.31
(5) Totals	1.46	1.46	1.46	1.69

Panel B: Percentage Distributions

I - Net National Product

(1) Labor Force	47.2%	47.2%	47.2%	34.8%
(2) Land Supply	9.6	3.3	9.6	2.5
(3) Capital Stock	25.9	28.1	23.6	18.6
(4) Productivity	17.3	21.4	19.6	44.1
(5) Totals	100.0	100.0	100.0	100.0

II- Net National Product per Capita

(1) Labor Supply	11.6%	11.6%	11.6%	6.7%
(2) Land Supply	3.6	1.6	3.6	- .6
(3) Capital Stock	37.5	28.6	31.5	16.4
(4) Productivity	47.3	58.2	53.3	77.5
(5) Totals	100.0	100.0	100.0	100.0

Table 6 (continued)

Sources: All of these figures, except the ones labelled "Land Supply, Var. A," "Capital Stock, Var A and B," and "Productivity, Var. A and B," were taken from Davis, Easterlin, Parker, et al., 1972 , Table 2.12, and Gallman (1980), Tables 1 and 2 underlying them or were computed from these tables or their underlying data.

The "Productivity" figures in Panel A were taken as residuals. The data in Panel A labelled "Capital Stock, Var. A and B" were derived by weighting rates of change with appropriate income share weights. The rates of change were taken from Table 5, above, (in the case of Panel A, Part I) or were computed by subtracting the rate of change of population from the rate of change in Table 5 (in the case of Panel A, Part II). The income share weight for the Variant B series (.19) was taken from the notes to Table 2.12 of Davis, Easterlin, Parker et al. (1972). The income share weight for the Variant A capital series (.26) was computed by raising the Variant B weight in the same proportion as the Variant A capital stock figure (current prices) exceeds the Variant B figure, in 1860. The average annual rate of change of the Variant A land supply figure was computed from Historical Statistics (1960), Series K-2, 1850-1900. The income share weight (.06) was computed by subtracting the capital stock weight (.26) from the sum of the land and capital stock weights (.32) employed for the Variant B calculations.

series leads to the conclusion that productivity change accounted for almost six-tenths of the growth of per capita N.N.P. in the nineteenth century. This is lower than the figure recorded for the twentieth century (almost eight-tenths), but is by no means low. The term "productivity" covers, of course, the influences of a multitude of forces operating on output. Perhaps a more meaningful way to put the conclusion is to say that the calculations in Table 6 (Variant A) assign to the factor inputs, narrowly defined, responsibility for only a little more than two-fifths of the increase in per capita real national product across the last six decades of the nineteenth century. The role of other forces, therefore, cannot be regarded as small.

Capital/Output Ratios

The capital stock increased faster than the national product, according to the data of Table 5. This means that the capital/output ratio was rising; the economy was engaged in capital deepening. Table 7 is organized to describe this process. The data leave something to be desired because, for the period before the Civil War, the ratios depend upon data referring to individual

years. The ratios, therefore, are influenced by events peculiar to these years and may not be fully representative of the period, 1840-1860. The post-war estimates are less susceptible to this criticism, since the national product data are decade averages, centered roughly on the years to which the capital stock figures refer (see the notes to the table). One should remember, also, that the estimates are not equally reliable; those for 1840, 1870, and 1880 rest on capital stock data that are probably less strong than the data for the other years. Differences in ratios between one year and the next should not be given undue importance. It is the general drift of the ratios that should be the focus of our interest.

The aggregate capital/output ratios (first two columns) do, in fact, rise over time, and this is true of both the Variant A and Variant B series, in current and constant prices. The Variant A ratios are much larger than the Variant B ratios, indicating the great quantitative significance of the component of capital consisting of farm land clearing, fencing, etc. (see, also, the fourth column), components included in Variant A, but not Variant B. The Variant A ratios also rise less rapidly than the Variant B ratios, reflecting the declining

capital, accounting for over two-thirds of the value of the stock in constant prices, by 1900 their share had fallen to about a third. Machinery and equipment, composing barely one-twentieth of the stock (constant prices) in 1840, were over one-quarter of the stock in 1900. Accompanying the capital deepening there was, then, a substantial re-shaping of the stock, with new forms of capital rising to prominence.

The last four columns of the table also throw some light on the nature of the decline in the capital/output ratio between 1860 and 1875. Changes in the ratios of inventories, equipment, and "other improvements" to output clearly are not responsible. The first rose moderately, in both current and constant prices, whereas the other two either changed very little (equipment, in current prices), or rose vigorously (equipment, in constant prices; "other improvements," in constant prices; "other improvements", in current prices). But the ratio of "farm improvements" to GNP declined very sharply (especially in current prices) and played a major role in the observed capital shallowing for the economy as a whole. This development may reflect the effects of the Civil War. In the South, some improved land was allowed to return to nature during the War, while

American balance of trade. In any case, this phenomenon also played a role in the decline of the capital/output ratio between 1860 and 1875 (Williamson, 1974).

An indication of the importance of this matter is easily obtained. The sum of the ratios in the last four columns of the table in each year approximates the Variant A ratio of domestic capital to GNP. The difference between this sum and the value in the first column measures the effect of net claims on foreigners on the national capital/output ratio. The sums and the entries from column for 1860 and 1875 are as follows:

	Current Prices		Constant Prices	
	Sum	Column (1)	Sum	Column(1)
1860	2.89	2.87	2.95	2.92
1875	2.77	2.59	2.94	2.80

The sums are almost identical with the first column values in 1860, but much larger than the first column values in 1875. More to the point, in constant prices the sums are almost the same in the two years, while in current prices the 1875 sum is only moderately below the 1860 sum. The decline in the aggregate national capital/output ratio, then, reflects both changes in the

Table 8 Sectoral Depreciable Capital/Value Added Ratios, Current and Constant Prices, 1840-1900

	1840	1850	1860	1870	1880	1890	1900
Current Prices							
1. Agriculture							
(a) Variant A	2.67	3.23	3.25	2.51	2.73	3.21	3.31
(b) Variant B	.75	.91	1.02	.90	.97	1.18	1.27
2. Mining, Manufacturing, and Hand Trades	.53	.52	.53	.61	.72	.80	.88
3. All Other Private Business (Excl. of Residences)	.85	1.02	1.24	1.15	1.23	1.43	1.38
(a) Transportation and Public Utilities	2.85	4.95	4.57	4.25	4.23	4.19	4.12
(b) Commerce and All Other Private Business	.35	.42	.58	.45	.53	.73	.68
4. Government and Education	1.76	2.16	2.34	2.39	2.93	1.99	2.34
5. Farm and Non-Farm Residences	4.75	5.33	7.87	6.28	8.86	11.30	11.00
6. Weighted Averages, Lines 1-4							
(a) Fixed (1860) V.A. Wts; Var.A	1.48	1.87	1.90	1.58	1.70	1.96	2.04
(b) Fixed (1860) V.A. Wts; Var.B	.75	.98	1.05	.97	1.02	1.19	1.21
(c) Fixed K/O Wts; Var.A	2.13	1.85	1.90	1.85	1.79	1.58	1.55
(d) Fixed K/O Wts; Var.B	1.12	.98	1.05	1.09	1.10	1.11	1.10

Table 8 (continued)

	Lines 6(a) and b	Lines 7(a) and (b)
Agriculture	.38	.35
Mining etc.	.24	.22
Transportation etc.	.07	.06
Commerce etc.	.29	.26
Government etc.	.02	.02
Residences		.09

Lines 6(c), (d), 7(c), and (d) were computed by multiplying the 1860 capital/output ratios in the body of the table by annual sectoral shares in total value added.

The shares are

Lines 6(c) and (d)

	1840	1850	1860	1870	1880	1890	1900
Agriculture	.45	.39	.38	.36	.31	.21	.20
Manufacturing, etc.	.19	.25	.24	.24	.27	.32	.33
Trans., etc.	.08	.05	.07	.07	.09	.10	.10
Commerce, etc.	.26	.29	.29	.31	.31	.34	.34
Gov't., etc.	.02	.02	.02	.02	.02	.03	.03

Lines 7(c) and (d)

Agriculture	.41	.35	.35	.33	.28	.19	.18
Manuf., etc.	.17	.22	.22	.24	.25	.30	.31
Trans., etc.	.07	.04	.06	.06	.08	.09	.09
Commerce, etc.	.23	.26	.26	.26	.29	.32	.32
Gov't, etc.	.02	.02	.02	.02	.02	.03	.03
Residences	.10	.11	.09	.09	.08	.07	.07

capital/output ratios computed from the former will show less tendency to rise over time than will capital/output ratios computed from the latter. That must be borne in mind when Tables 7 and 8 are compared.[22]

I begin with three sectors: agriculture; mining, manufacturing and hand trades; all other private business. The estimates for these sectors are relatively strong (that is, compared with the estimates on which the other ratios in the table depend), the capital and value added estimates are independent, in each case, and the sectors are sufficiently broad so that one can hope for a modicum of stability in the ratios.

All of the series, except for agriculture, Variant A, show quite pronounced upward movements over time. The Variant A series shows no very clear trend, in either current or constant prices. The Variant B series and the ratios for the "all other private business" sector rise strongly before the Civil War, flatten out between 1860 and 1880, and then rise again strongly, while the "mining, manufacturing, and hand trades, sector exhibits a ratio that neither rises nor falls" before the War, but increases strongly from 1860 to 1900, in both current and constant prices. It would be fair to say, then, that the upward

residences, farm and non-farm. Since the capital stock series do not distinguish farm residences, I was obliged to include all farm buildings in the numerator, which means that all of the ratios for this sector are biased upward. Furthermore, the denominator was initially estimated on the basis of capital stock data (see Gallman and Weiss, (1969)), although not the capital stock data appearing in the numerators of these ratios. Thus the ratios cannot be taken very seriously. I include them for the sake of completeness and because the data do figure, in another form, in Table 7, and the reader is therefore entitled to know something about them.

Whether or not the estimating procedures were proper (for the purpose of measuring the capital/output ratio), the relationships obtained between value added and the capital stock of the "residences" sector are plausible. Reversing the ratios and adding land to residential capital, we have estimates of the rate of return (gross) to residential property. The computed rate follows fairly closely the pattern of the interest rate (at least from 1860 onward), a result which might have been anticipated on theoretical grounds. Thus at least the value added and capital stock data for this sector seem consistent.

the data exclude certain types of capital. But that is certainly not all there is to it. The residential and transportation and public utilities sectors were, in fact, more capital intensive than were the secondary sectors, for example. Since the structure of the economy was changing in important ways, the level of the aggregate capital/output ratio may have been influenced by the shifting relative importance of the various sectors. Lines 6 (a)-(d) and 7(a)-(d) were computed to help settle that issue. The lines contain various weighted average capital/output ratios, sets of calculations appearing for both Variant A and B estimates, and for both all sectors and all except the questionable "residences" sector. In one set of calculations (6(a) and (b); 7(a) and (b)), sectoral value added weights were held constant and sectoral capital/output ratios were allowed to vary over time; in the other (6(c) and (d); 7(c) and (d)), capital/output ratios were held constant, while value added weights were allowed to change over time. The first set of calculations shows the effects of rising sectoral ratios on the aggregate ratio, no allowance being made for the effects of structural changes. In the second set, only

change that worked against the downward movement of the overall ratio was the growing relative size of the transportation and public utilities sector, with its exceptionally large capital/output ratio.

All of these structural developments were inter-related: all were part of the general process of modernization, which consisted of the transfer of economic activities into the orbit of the market, increasing specialization and trade, and the movement of information and goods over longer distances and at faster rates.

While these structural changes had no pronounced direct effect on the depreciable capital/output ratio,[24] they did influence the means by which the capital stock was assembled. In the ante bellum years, almost half of the depreciable capital stock (constant prices) consisted of agricultural land improvements, many of them created by family labor, or the labor attached to the plantation on which they were constructed, or by other local sources of labor. These works were typically carried out in the off season--in the spaces in the agricultural year when there were no pressing tasks--e.g., planting or harvesting--associated with the growing crops. Little external finance was required to carry them out. But the structural changes of modernization

Table 9 Capital Formation Proportions, Constant Prices, 1839-48 through 1889-98

	National Capital			Depreciable Capital			
	Var. A	Var. B		Var. B			
	Net	Net	Gross	Net I	Net II	Gross I	Gross II
1839-48	12.2%	9.6	14.3	6.0	5.5	11.1	10.6
1849-58	15.7	13.3	18.7	10.7	8.8	16.4	14.8
1869-78	13.1	11.0	18.6	7.3	15.4	15.5	22.3
1879-88	18.2	17.5	25.8	15.4	13.6	24.1	22.6
1889-98	14.8	13.8	25.3	11.1	17.3	23.2	27.9
1839-58	14.4	12.0	17.1	9.0	7.5	14.5	13.1
1869-98	15.7	14.6	24.2	11.9	15.5	22.0	25.0

Sources:

The denominator of each ratio is the sum of the numerator plus the value of flows to consumers, prices of 1860 (Gallman (1960), p. 27, Col (5)). The numerators are as follows:

Col (1): Increment to the national capital stock, 1860 prices, 1840-1850, 1850-1860, etc.

Col (2): Increment to the domestic capital stock, 1860 prices, 1840-1850, 1850-1860, etc.

Col (3): The numerators from Col(2) plus capital consumption, the latter estimated at 10% of the value of machinery and equipment and 4% of the value of improvements (exclusive of farm land clearing, etc.). These estimates approximate straight-line capital consumption on the assumptions that machinery and equipment had a useful life of 15 years and that the

commodities and services to consumers (1839-48, 1849-58, etc., Gallman, 1960, p. 27) to form estimates of net product (Table 9, Cols (1), (2), and (4)). This procedure does not result in useful estimates if current price stock data are employed; thus the estimates in Table 9 all rest on constant price data. It should be said, however, that even the constant price estimates leave something to be desired, in view of the moderately ambiguous conceptual character of the stock estimates (see Section 2, above).

In the second procedure, net investment flows are estimated by subtracting from gross investment flows (Gallman, 1960, p. 34) the value of capital consumption (Table 9, Col (5)). The latter can be estimated from the capital stock data, given estimates of the average age and useful life of the various components of the depreciable capital stock. The flow data are of such a character that investment proportions can be estimated for depreciable capital. Given estimates of capital consumption, it is also possible to generate gross investment shares, in which the measurement of gross investment depends exclusively on stock data (Table 9, Col (3), Col (6)). Of course gross share estimates can also be made directly from the flow data (Table 9, Col

from the flow data (Col (5)) than from the stock data (Cols (1), (2), and (4)), however, and from the measures incorporating a narrow definition of capital (Cols (2) and, particularly, (4)) than from the ones based on a broad definition (Col (1)).[27]

The increase in the net investment proportion required an even more pronounced increase in the gross investment proportion (Cols (3), (6) and (7)). The explanation is not far to seek: the rising depreciable capital/output ratio meant that, ceteris paribus, the share of capital consumption in national product was rising. But other things were not, in fact, equal: the structure of the depreciable capital stock was changing, the shorter-lived machinery and equipment increasing in importance relative to the longer-lived improvements. This structural change increased the share of national product accounted for by capital consumption.

These two developments meant that the share of the GNP (concept adopted by Gallman (1960)) accounted for by gross investment more than doubled between the 1840's and 1890's. One must further remember that the forms of investment and their relationships with the market were changing.

5

Section 4 constitutes a brief precis of some of the main results derivable from the new capital stock series. Limitations of space and competence prevent me from adding to them and showing more clearly the place of capital in nineteenth century history. As I have indicated previously, I have been concerned here chiefly to introduce the new series, to explain their pedegrees and character, and to show the principal conclusions to which I have been drawn as a result of mulling them over and comparing them with related variables. I hope to write more fully on these matters later. In the meantime, the task of introduction is fairly begun. Perhaps soon the series will be able to go out into the world on their own, where their rough edges will be knocked off them in the give and take of scholarly discussion. Whether, when this process is over, they retain anything of use and value, time will tell.

FOOTNOTES

1. This paper, however, is concerned exclusively with the period 1840-1900.

2. The topics treated in Section 2 are of a type that has been discussed at earlier meetings of the Conference. See, in particular, Volumes 2, 12, 14, 19, 25, 29, and 45, and especially the papers by Edward Denison, Raymond Goldsmith, Simon Kuznets, Nancy and Richard Ruggles, and Dan Usher, and the comments on them.

3. The following discussion was developed with fixed capital chiefly in mind, although it can also be made to apply to inventories and international claims, with two exceptions: there is no clear correspondence between "acquisition cost" and any single system of inventory accounting. For present purposes, that is not an important matter. All inventories treated herein are valued at market prices. So far as international claims are concerned, there is no good counterpart of reproduction cost (other than market price).

7. I ignore here the problems posed by taxes and subsidies, problems of modest dimensions through most of the nineteenth century.

8. See, also, Kuznets's objection, voiced in his paper in Volume 2 of Studies in Income and Wealth (1938).

9. This is particularly true with respect to the manufacturing sector, which was experiencing extraordinarily high rates of growth.

10. That is, the fit for 1840 is as good as the fit for 1850 or 1860; the fit for 1870 is at least as good as the fit for 1880, 1890, or 1900.

11. Following Kuznets (1946), we produced a separate set of estimates--distinct from the agricultural estimates--of irrigation improvements, which we treated as part of he capital stock.

12. For present purposes, the "old" series is the one published in Gallman, 1965, which includes some components of wealth (e.g. inventories)

18. These results were worked out from Goldsmith, Lipsey, and Mendelson (1963), Volume II, p. 71, which is the source of the 1900 data in Goldsmith (1982).

19. It is well known that the deflation-base selected can affect the rate of change of a real capital stock series, earlier bases typically producing higher rates of growth than late ones. It is therefore fortunate, for present purposes, that the deflation bases of the two series being considered here occupy similar relative temporal positions. Thus the Goldsmith series is deflated on the base 1929, 28 years from the first year in the series and 51 from the last; the Gallman and Howle series, on 1860, 20 years from the first year in that series and 40 years from the last.

20. Throughout I use the dating scheme relevant to the capital stock series (1840, 1850, etc.). Notice that the GNP series is dated to different years than these, the disparity being particularly wide in the case of the first post-Civil War date. See the notes to Table 5.

1889	1899
1.00	1.00

The reconciliation between the two series is by no means perfect; the upward movement of the ratio from 1879 to 1889 is more than negligible. Nonetheless, the long-term trend is much reduced in the second tabulation, as compared with the first, and the variations from one year to the next are not large, in the context of the observed annual changes in GNP.

23. If the measure of capital employed here had included inventories, this result might have been different.

24. The indirect effects, through changing supply and demand conditions for capital goods, constitute another matter. The rapid expansion in the stock of machinery and equipment, for example--a development that, we have seen, played a role in the rise of the overall capital/output ratio--was related to the revolutionary growth of the industrial sector (mining, manufacturing, hand trades).

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